Chapter 5
CERCLA and RCRA Investigations

5-1. Background

Sites containing mixed hazardous and low-level radioactive wastes are designated MW sites. Although MW falls within the recognized jurisdictions of both the NRC and the EPA, the latter Federal agency has undertaken the monitoring and enforcement of regulations or has delegated those responsibilities to particular states for regulating activities on those sites. Compliance with NRC regulations at MW sites is enforced through site-specific agreements between the NRC and EPA (and state, if so authorized). Regulation of MW site remediation is carried out under the RCRA and CERCLA. Although CERCLA has a generally wider application to site remediation and restoration, it is concerned with the assessment and cleanup of inactive facilities and abandoned sites. Additionally, by means of the Superfund Amendments and Reauthorization Act, CERCLA provides that Federal entities are subject to the requirements for cleanup, just as are commercial facilities. The initial procedures required by both RCRA and CERCLA have essentially identical goals: to delineate the contaminated site, the nature of the contamination, the extent of the effects on environment and populace, and screening of appropriate and feasible means of remediation. Under CERCLA procedures, these goals are accomplished by "remedial investigations/feasibility studies" (RI/FS). Under RCRA procedures, the complementary efforts are "RCRA facility investigations/corrective measure studies." Abandoned sites which are not included on the NPL may undergo engineering evaluation and cost analysis studies (EE/CA) directed towards possible remediation or removal actions. 40 CFR 300.415 states that any release, regardless of site status on the NPL, may call for use of removal actions, subject to regulatory control of the actions.

5-2. Initial Evaluations

a. Description. These evaluations provide a description of what is known of the site and its problems and are the basis for planning and accomplishing the remedial or facility investigations. As with all investigational work plans and efforts, pursued and collected data quality management will ensure that the type, quantity, and quality of data are highly directed to and meet all objectives of the remediation project. The following subjects will be included in the initial evaluations:

(1) A physical description of the site.

(2) A history of the site usage oriented towards potential contamination.

(3) Known and suspected contamination.

(4) A preliminary conceptual model of contaminant transport on and around the site, pathways, and receptors.

(5) A comparison of potential regulatory controls relevant to the site and its contaminants.

(6) A preliminary assessment of risks to the populace and environment.

(7) A brief summary of potential remedial alternatives.

b. Site location and delineation. The initial site description, in most cases, will have been provided by the requesting and responsible state or Federal agency. The site will have been initially screened to identify, in a general nature, the hazards and evaluate its priority for remediation efforts. Though some of the screening study data will not be of use to engineering problems, the entire body of data must be examined critically and in detail to identify the areas of greatest concern. The officially recognized boundaries of the site must be defined along with pertinent geographic and cultural features such as buildings, excavations, transportation paths, etc.

c. Contaminant source locations. Chemical and radioactive material and waste storage areas must be described. These may include storage buildings, process buildings and other structures, tank farms, lagoons *or* excavations, or refuse dumps of containerized or exposed materials. Because the LLRW constituent of MW can comprise virtually any artificially created or modified objects, great care and intuitive investigation may be required. In addition to waste storage areas or improper disposal areas themselves, the access paths used to gather the waste together must be examined for contamination. Physical egress paths of waste or waste-contaminated intruders must be specifically ruled out by investigation or followed if found. It may be found that the necessary survey boundaries should be expanded to encompass such inadvertent releases. In the opposite sense, it may be found during the preliminary assessment and remedial investigations that subdivisions of an overall, larger site may be more appropriate in terms of priority, remediation methods, and management purposes. USACE should be alert to such modifications to the scale of the overall remediation effort and be prepared to obtain the necessary authorizations from the site owner and the regulatory agency.

d. Contaminant material identification.

(1) LLRW. Low-level radioactive waste can consist of virtually any type or configuration of material used in laboratories, chemical processes, medical, and industrial operations. The LLRW must be verified to not be high-level, that is, it may not be used fuel rods or reprocessing waste, it may not be specially classified because of its high activity, nor may it contain transuranic elements. High-level waste excluded, the sole criterion for LLRW is the presence of radioactivity as defined in NRC regulations. Mundane examples include janitorial supplies or in situ soil contaminated by radionuclides; exotic examples include research laboratory animal carcasses or nuclear medicine diagnostic equipment. The preliminary site assessment survey provided to USACE should (but may not) include historic records as to the general source and nature of materials brought into or generated at the site. That historical record should be verified and expanded as much as possible. Onsite preliminary investigations may include instrumental surveys (Geiger counters, scintillation detectors, etc.) and sampling by wipe procedures on objects, limited sampling of soil and water, and sampling of atmospheric and soil gases for detailed laboratory evaluation. Selected surveys and analyses should serve specific objectives in the investigation but, at this stage of investigation, a more general plan is required because of probable incompleteness of site knowledge. The background radiation levels on and around sites potentially contaminated with LLRW and MW must be determined in this initial evaluation. The measured background levels give data to which localized contaminant levels can be compared. The background levels will be rechecked periodically through all stages of investigation and remediation and contaminant level comparisons made with the most applicable background radiation data.

(2) MW. The additional component of hazardous or toxic chemicals in MW widens the scope of historical and onsite identification surveys and complicates the safety and health precautions necessary but will be accomplished in the same intensive detail as identification of radioactivity at the site. This stage of investigation is early and a large base of site data is unlikely. Data quality management will reflect the need of more data for future target identification and for statistically meaningful risk assessments.

e. Potential transport pathways. Contaminants, both radioactive and toxic, can be transported around or off the defined site by air flow, groundwater flow, surface water flow, air- or waterborne sediment, and biotic movement. Data from the past history of site usage and monitoring will aid in developing reasonable transport pathway concepts. Data may be sparse and unevenly distributed or absent. In the preliminary stages of focusing the remedial investigative effort, it will be necessary to integrate contaminant, hydrodynamic, geohydrologic, geologic, and biologic principles to develop the conceptual contaminant pathways from source to receptor. An important objective of the effort to model potential transport pathways and receptors is to establish strategic locations for sampling in the later stages of investigation.

(1) Airborne transport. Frequent or seasonal high wind conditions must be considered together with ground cover and moisture conditions to establish the potential for contaminant transport. Most often, dust or blowing trash will be the transport medium. Development of the transport model should not ignore the potential for toxic or radioactive vapor or gas releases and appropriate investigations should be made.

(2) Groundwater transport. A primary pathway for migration of both radionuclides and toxic chemicals is by way of the flow of groundwater beneath the site. Detailed geohydrological investigations will be a major part of the effort carried out during the RI/FS process to define the quantities and rate of downward seepage from the surface, through or past the MW, through intervening strata to the water table, and through both aquifers and aquitards. As much information as possible should be gathered during preliminary investigations to characterize groundwater under and around the site. Depending on the site climate, history of usage, MW physical and chemical characteristics, and geohydrological characteristics, leached radionuclides or chemicals may be found to have contaminated strata and groundwater to some degree. That contamination poses a potential immediate risk to the public that must be evaluated as soon as its existence is noted. Also, contaminated groundwater (if discovered) will be a health and safety hazard to onsite investigators which must be accommodated in the health and safety plan.

(3) Surface water transport. At the minimum, meteorological histories and characterizations will be possible in the preliminary stages of investigation. These

data, along with observed water flow paths, allow characterizations of potential pathways by that route, assessment of the resultant risks, and identification of vulnerable receptors.

(4) Biotic transport. In the absence of a prior life form monitoring program at the site, it will be necessary to extrapolate animal and plant population characteristics from short-term observations and regional data. Land animals, birds, and fish, both resident and visiting, may be mobile vectors for chemical and radioactive contaminants, transporting them both externally and internally. Other aquatic animals besides fish are less mobile but may still move with the surface water. Vegetation pathways frequently occur by animal ingestion and subsequent evacuation elsewhere.

(5) Projected life of hazard. Although decomposition occurs, the hazardous component of MW is not characterized by the regulatory framework as having a definite lifetime. The hazardous nature is controlled by the chemical's stability under ambient physical-chemical conditions and by dilution. Radionuclide components of MW, on the other hand, have distinct life-spans unaffected by ambient conditions. These life-spans (described in terms of half-life) result in steadily decreasing concentrations as time passes. "Daughter" radionuclides are produced by this spontaneous decay and must themselves be considered in the waste inventory. Half-lives are a primary basis for LLRW classification and consequent disposal requirements. A typical rule of thumb signifying meaningful radioactivity within decay sequences is 7 to 10 half-lives of the longest-lived daughter product. Analytic definition of the radionuclides present in the MW thus provides the information necessary for the performance-based goals of selected disposal methods, the levels of risk that define the degree of hazard, and the projected life of the hazard.

5-3. Remedial Investigations

a. Basis for investigation approach. The basic reason for undertaking the remedial investigation is to produce data necessary for rational decisions in assessing the level of risk associated with the site and its hazards. That assessment of risk, backed by its database, allows determination of the feasibility of alternative remedial actions. Common practice, encouraged by current EPA (EPA 1987) and other agency guidance, is to perform the remedial investigations in phases. This is intended to optimize the quantity and quality of the data by keeping the investigating effort focused on specific remedial action feasibility.

b. Approach of investigations. In the initial phase of investigation, reliance will be placed on screening level data, subsequently expanded by detailed data from targeted investigative efforts. The basic concept of the approach is to maximize the extent of reliable, useful information obtained for reasonable resource investment and reserve highly concentrated investigative efforts for detailed risk or remedial action feasibility studies. Besides avoiding redundancy of investigative efforts, such a phased approach to investigations also minimizes generation of radioactive and hazardous waste by the act of remedial investigation. Especially in the area of monitor wells and sampling borings, careful phasing and close targeting of the borings only where they are most needed will minimize inadvertent cross-connection of contaminant pathways.

c. General types of investigations.

(1) Source locations. Topographic base maps of the site will be created and kept current which show existing facilities, known contaminant sources, survey locations, and other data as they are generated. The base maps may be subdivided into more detailed parts for large, multi-unit sites. The maps should be of third-order precision with contour intervals of 2 ft (0.6 m). Surface radiation surveys should be conducted in a methodical, well-recorded manner at the field screening level of precision. Methodical, well-recorded walk-over reconnaissance examinations of the site should be conducted to screen for hidden waste. Historical aerial photographs, recent aerial photographs, and aerial examinations may be used to search for old drainage paths, trenches, pits, or other crypto-archeological evidence of possible contaminated areas. Surface-based geophysical reconnaissance may include ground-penetrating radar, magnetometer, or electromagnetic induction surveys to locate shallow buried waste forms.

(2) Structural investigations. Structures on a potentially contaminated site are primary targets of investigation for radioactivity and for bulk waste materials. Interior walls, doorways, floors, workbenches, ventilation system components, plumbing, etc., are the types of surfaces in buildings which may have been accidentally contaminated in the past. Containers such as tanks, pipes, reservoirs, dry wells, and cisterns could act as catchments for contaminated waste materials at old sites. Maintenance areas near buildings such as wash racks, motor pools, etc., also can be areas of concentrated contamination.

(3) Vadose zone and soil investigations.

(a) The specific objective of vadose zone and soil investigations is a detailed characterization of the subsurface above the groundwater or aquifer. Very shallow zones at critical locations near disposal units or drainage structures may be examined by means of excavated test pits. Radiological and chemical analysis samples may be obtained from pits, and lateral variations of near-surface materials may be examined in excellent detail. Borings will be made and samples retrieved from them for analysis and for engineering properties. Typically, analysis samples are obtained from the borings in which groundwater monitor wells are to be placed. This is efficient and provides direct point information on the nature of the subsurface materials and the contaminants at the monitoring location. Specifications for sampling equipment and method of drilling are dependent on the site and engineering considerations. In particular, the method of drilling must preclude cross-contamination and minimize contaminant migration. Aller et al. (1989) present a complete description of current monitoring well practices. Specific studies of contrasting drilling practices between HTRW and radioactively contaminated sites have not been made. Commonly used drilling equipment or supplies used at an LLRW or MW environmental restoration site should, at the minimum, be shown to not increase background levels of radioactivity.

(b) Criteria for sampling frequency are site-dependent and hazard-risk-dependent, i. e., with no reasonable expectation of serious contamination the specification may take the form of a sample taken every several feet or, at a grossly contaminated spot, the subsurface samples may need to be essentially continuous to completely delineate stratification. Lithologic classifications and many properties of recovered samples will be collected from this phase of subsurface investigation. Those physical characterizations will be used to support the engineering portions of remedial actions.

(c) All excavations made for subsurface investigations which are not to be maintained or further developed for monitoring purposes will be backfilled. The backfilling method is to prevent cross-connection between water-bearing zones and to prevent release of subsurface contaminants to the surface. Backfilling methods will be described in the investigation work plan.

(d) Borehole geophysical logging will be performed in selected borings and will include natural gamma, gamma-gamma density, neutron-epithermal neutron water content logs. These and any other geophysical logs, the lithologic logs, and samples will be used to develop vertical profiles of strata and for lateral strata correlations. Surface-based geophysical surveys of the vadose/soil zone include those methods such as electrical resistivity and seismic refraction which can be used for engineering information as well as delineation of water tables and lateral material variations. The screening level surface geophysical surveys performed to locate contaminated areas will also provide data for the near subsurface characterizations.

(4) Groundwater investigation. Groundwater may be in the form of confined or unconfined aquifers. In some special cases, the groundwater of a particular portion of a major MW site may be designated as the operable contaminated unit to be investigated and remediated quite apart from the ground surface above it. Most often, however, the groundwater is incorporated in site actions. The water table (potential piezometric pressure in the case of confined aquifers) configuration, including its sources, sinks, and communication with surface water, will be characterized accounting for seasonal, etc., changes. Monitoring wells will be located strategically to fill gaps in the coverage of prior data. Clusters of wells will be used to investigate individual hydrological horizons, interconnections, and gradients. Monitoring wells satisfy multiple purposes. Water levels and changes indicate seasonal variations in the site hydrology. Water samples are analyzed for natural chemical characteristics (pH, cations, anions, etc.) as well as contamination. Gasses above the water in the wells can be investigated for radon or tritium concentrations. Aquifer testing in the wells will provide transmissivity and storativity data characterizing the aquifer. Aquifer testing may be performed in single wells as so-called slug tests rather than as large-scale pump tests if it is not feasible to treat, store, or dispose of potentially contaminated pumped water. Reinfection of the pumped water back into the aquifer is a possible alternative but must be very carefully thought through because of the potential for degrading the pump test data and for adversely affecting the groundwater regime. Though the investigated volume of aquifer tested by slug methods will be quite small, potentially contaminated water will not be brought to the surface. Properly designed and developed monitoring wells will continue to provide data throughout the latter stages of RI/FS, during actual site restoration, and afterwards can allow monitoring the effectiveness of the actions. Temporary wells or other expedient means of sampling subsurface water may be economical. Temporary wells or expedient access to an aquifer must be controlled to not cross-connect separate aquifers and to be properly backfilled and sealed when decommissioned.

(5) Surface water and sediment investigation. Contaminants may reach surface water bodies and sediments by way of past direct discharges, runoff, outflow of contaminated groundwater, or from upstream sources unrelated to the particular site. Many direct discharge pathways can be discerned from old drainage structures or other facilities found during preliminary and remedial investigations. Runoff from sites on high ground will be controlled by meteorological conditions during the site's history modified by the site topography, geology, vegetative cover, and seasonal climate. In addition to meteorological runoff, sites located on low ground such as flood plains or valleys may experience flooding due to distant storms, snowmelt, or human construction activities. In such a low site, backwater flooding arriving from downstream may also be a possibility to be considered in planning remedial actions. Geology may also assist methodical observations in locating springs or seeps of subsurface water. Stream channel cross sections will be measured at locations appropriate to characterize both the surface hydrology and the specific sampling points. Each point or area determined by deduction and surface inspection will be subject to a detailed program of water and sediment sample recovery and analysis. Direct field measurements of radiation levels and distributions, flow rates, temperature, pH, and electrical conductivity will be performed at each designated water/sediment monitoring point. Sampling and direct field measurements will be continued at the designated points to develop a time record of changes during site restoration. Findings of this set of investigations will influence the planning of aquatic biological investigations.

(6) Air investigation. The objectives are two-fold: to assess personnel exposures during field investigations and to characterize particulate contamination spread by air transport. Historical meteorological data will be compiled from the nearest effective measurement stations. Some sites may be remote from established measurement stations and meteorological stations will need to be created nearby (not directly onsite so as to simplify personnel access to the station). Precipitation, temperature, wind characteristics, barometric pressure, vertical atmospheric variations, weather extremes, air quality, relative humidity, and evaporation rate are the primary measurement items. Direct air monitoring for volatile hazardous compounds and radiation will be required by the health and safety plan for all initial reconnaissances and intrusive activities such as digging and drilling. Air sampling will be done during all intrusive activities such as drilling by using high-volume air samples. The sampling filters will then be analyzed in the laboratory for radioisotopes that the site history and prior measurements indicate may be present. The radiation levels will be compared with background levels obtained at specially designated reference points. Exceedance of the backgrounds by certain proportions will dictate appropriate safety and health precautions and a more detailed and extensive series of samples and analyses.

(7) Biological investigations. Contaminant source location surveys and surface water investigations will influence the planning of biological studies. Observation of data quality objectives will ensure that the biological studies are directed to well-defined species and contaminant targets. Assessment of the risks to the biota, as well as human populations, will be the primary reason for all biological investigations at LLRW and MW remedial sites. These studies will evaluate the nature and extent of contamination in plants and animals, identify members of the ecosystem, identify critical habitats and endangered species, and characterize the ecological relationships of the site with reference to past contamination and the effects of restoration activities. An appropriate number of sampling stations will be established to obtain terrestrial species and sampling stations will also be established for aquatic species. These latter aquatic sampling stations will also be used as surface water and sediment sampling stations. All plant and animal samples collected will be analyzed for radionuclides. Chemical contaminants determined by historical review and laboratory analyses of soil, groundwater, or surface water to be present onsite will be targeted in biological assays.

(8) Cultural resource investigation. Cultural resources include both prehistoric and historic artifacts and sites. A literature search and interviews of descendants and cultural groups will be conducted to provide a basis for characterizing the site cultural resources. A qualified field archeologist will conduct a field survey of the entire MW site prior to any intrusive remedial investigations. Those sites determined by the literature search and personal testimonies will be verified as to location and nature. Additional undescribed sites of cultural relevance will be duly characterized as found. Particular care will be taken in the areas of planned remedial intrusive activities. Discovered cultural resources vulnerable to remedial activities may force relocation of the point of investigation or may require development of a cultural resource data recovery plan (i. e., "harvest" all possible archeological/cultural data to the point of the destruction of the site with regulatory approval). Data from remaining cultural sites will be incorporated into all feasibility studies as impacts on the remedial actions.

5-4. Report of Remedial Investigations

At the completion of remedial investigations, a report will be prepared. This report may be a singular document or may comprise a portion of a more general report of remedial investigation. It will consist of a summary of the characterization of the LLRW or MW, the site, and their effects on the human populace and environment. The conceptual model against which the remedial action alternatives are to be cast will be described; sources of contamination will be fully described; the nature and extent of contaminant ion in soil, air, groundwater, surface water, sediments and life forms will be described; a complete list of pertinent regulations will be provided together with the manner they impact site remedial actions; and risks posed to humans and the environment by undertaking no action or any remedial activities will be presented. The remedial investigation data reported will support the selection (or rejection) of alternative remedial actions to be taken and will provide the engineering data necessary for design and accomplishment of the site restoration.